

INSTRUCTION MANUAL
FOR
OXYGEN ANALYZER

MODEL 315
SERIAL NUMBER

Teledyne Analytical Instruments
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MATERIAL SAFETY DATA SHEET

Section I - Product Identification

Product Name: Micro Fuel Cells, all classes except A-2, A-3, A-5, B-2F and B-2CF.
Electrochemical Oxygen Sensors, all classes except R-19.
Mini micro-fuel cells, all classes.

Manufacturer: Teledyne Analytical Instruments

Address: 16830 Chestnut Street, City of Industry, CA 91749

Phone Number: (818) 961-9221

MSDS Prepared By: Chuck Molloy

Date Prepared or Last Revised: 3-31-88

Emergency Phone No.: (818) 961-9221

Section II - Physical and Chemical Data

Chemical and Common Names: Potassium Hydroxide (KOH) 15%
Granular Lead (Pb) pure

CAS Number: KOH 1310-58-3
Pb 7439-92-1

Melting Point/Range: -10 to 0 Deg. C

Boiling Point/Range: 100 to 115 Deg. C

Specific Gravity: 1.09 @ 20 Deg. C

pH: >14

Solubility in Water: Completely soluble

Percent Volatiles by Volume: None

Appearance and Odor: Colorless, odorless solution

Section III - Physical Hazards

Potential for Fire and Explosion: The electrolyte in micro-fuel cells is not flammable. There are no fire or explosion hazards associated with micro-fuel cells.

Potential for Reactivity: The sensors are stable under normal conditions of use. Avoid contact between the sensor electrolyte and strong acids.

Section IV - Health Hazard Data

Primary Route(s) of Entry: Ingestion, Eye/Skin Contact

Exposure Limits: OSHA PEL .05 mg/cu.m. (Pb)
ACGIH TLV 2 mg/cu.m. (KOH)

Effects of Overexposure:

Ingestion: The electrolyte could be harmful or fatal if swallowed. Oral LD50 (RAT) = 2433 mg/kg

Eye: The electrolyte is corrosive and eye contact could result in permanent loss of vision.

Dermal: The electrolyte is corrosive and skin contact could result in a chemical burn.

Inhalation: Liquid inhalation is unlikely.

Signs/Symptoms of Exposure: Contact with skin or eyes will cause a burning sensation and/or a soapy feeling for skin contact.

Medical Conditions Aggravated by Exposure: None

Carcinogenicity:

NTP Annual Report on Carcinogens: Not listed.

IARC Monographs: Not listed.

OSHA: Not listed.

Other Health Hazards: Lead is listed as a chemical known to the State of California to cause birth defects or other reproductive harm.

Section V - Emergency and First Aid Procedures

Eye Contact: Flush eyes with water for at least 15 minutes and get immediate medical attention.

Skin Contact: Wash affected area with plenty of water and remove contaminated clothing. If burning persists, seek medical attention.

Ingestion: Give plenty of cold water. Do not induce vomiting. Get medical attention.

Inhalation: Liquid inhalation is unlikely.

Section VI - Handling Information

Handling Precautions: Note: The oxygen sensors are sealed and under normal circumstances, the contents of the sensors do not present a health hazard. The following information is given as a guide in the event that a cell leaks.

Protective Clothing: Rubber gloves, chemical splash goggles.

Clean-up Procedures: Wipe down the area several times with a wet paper towel. Use a fresh towel each time.

Protective Measures during Cell Replacement: Before opening the bag containing the cell, check the cell for leakage. If the cell leaks, do not open the bag. If there is liquid around the cell while in the instrument, put on gloves and eye protection before removing the cell.

Disposal: Should be in accordance with all applicable state, local and federal regulations.

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DRAWING LIST

RECOMMENDED SPARE PARTS LIST

1. INTRODUCTION

1.1 Method of Analysis. The Teledyne Analytical Instruments (TAI) Series 315 Solid State Trace Oxygen Analyzer utilizes a unique, patented Micro-fuel Cell to electrochemically measure the concentration of oxygen in a gas stream. The cell has an absolute zero and produces a linear output from the low parts per million (ppm) level through 21% (210,000 ppm) oxygen. When coupled with a "state of the art" two stage amplifier system that incorporates a hybrid operational amplifier and an integrated circuit (IC), the cell provides linear trace oxygen analysis in the ranges of 0-10 and 0-100, (other ranges are optionally available). No zero gas is required, and the instrument may be calibrated with air (obviating the use of questionable "certified" trace oxygen calibration gases).

1.2 Standard Features. The following outstanding features are incorporated in the Series 315 Trace Oxygen Analyzer line:

1.2.1 Micro-fuel Cell. The Series 315 sets a new standard in maintenance-free operation. The Micro-fuel Cell is a sealed electrochemical transducer with no electrolyte to change or electrodes to clean. When the cell reaches the end of its useful life (6 months minimum), it is merely thrown away and replaced, as one would replace a battery in a flashlight.

The cell is specific for oxygen and is not influenced by sample flow rate or the presence of reducing agents, such as hydrocarbons, CO, SO₂, etc. A nominal flowrate of 1.0 scfh (approximately 600 cc/min) is maintained through the instrument in the interest of an acceptable response time (90% in less than 10 seconds for ranges 0-100 ppm or greater) consistent with low consumption of sample gas.

1.2.2 Temperature Compensation. The Model 315 utilizes a thermistor controlled temperature compensation circuit to maintain $\pm 5\%$ of reading or $\pm 2\%$ of scale accuracy (whichever is greater) over the operating temperature range (32 to 125°F). Employing the compensation approach, rather than temperature control method, provides acceptable accuracy over a wide range of ambient temperature fluctuation and eliminates the maintenance problems that normally accompany the components associated with an electrical heating system.

1.2.3 Meter Readout. The Model 315 is equipped with a panel meter for direct readout of the analysis. A linear 50 division scale (mirror equipped to eliminate parallax) promotes reliable, accurate readout of the analysis at any point on the scale. The resolution and accuracy of the instrument's meter ($\pm 2\%$ of full scale) obviates the necessity of an accessory readout device -- unless greater accuracy or a permanent recording of the analysis is required.

1.2.4 Output Signal. For those applications requiring a continuous recording of the oxygen content of the sample, a linear output signal of from 0-1 millivolt to 0-1 volt D.C. is available at no extra charge. Unless otherwise specified at the time of purchase, the output signal will be 0-1 volt D.C.

The output signal, regardless of magnitude, is suitable for driving external devices that have an input impedance of 10,000 ohms or more.

1.2.5 Dual Range Analysis. The Model 315 accurately measures oxygen in the ranges 0-10 ppm and 0-100 ppm. Range selection is accomplished by the positioning of the toggle switch located below the readout meter.

In addition, a "CAL" position is provided to extend the range of measurement to include the oxygen concentration of air. With the selector in this position, the instrument may be accurately calibrated by using instrument air and the "CAL" mark on the meter dial to set the span control.

1.2.6 Speed of Response. With a sample flowrate of 0.25 scfh, the Model 315 achieves 90% response in 10 seconds to step changes in oxygen concentration in ranges of 0-100 ppm or greater. In the range 0-10 ppm the response time is 60 seconds. In general, the response of the Micro-fuel Cell is significantly superior to that of most electro-chemical trace oxygen measuring systems currently on the market.

1.2.7 Compact Packaging. The Model 315 offers all the foregoing features as well as an integral throttle valve, flowmeter, and shutoff valve, in a package that utilizes little more than $4\frac{1}{2} \times 11$ inches of panel space. For most applications, pressure reducing devices for the sample and calibration air (either metering valves or regulators), and a simple two valve selector manifold are all the accessory equipment that is

required to operate the analyzer.

Access to the terminal strip for connecting power-in and analog signal-out is made by removing the small cover plate on the upper rear of the analyzer. Additional working space can be obtained when fitting conduit, etc. to the analyzer by removing the left side panel (when viewed from the rear). Sample-in and sample-out connections are made via the Swagelok connections located on the lower rear of the analyzer (see Interconnection Drawing).

2. INSTALLATION

2.1 Location. The analyzer must be installed in an area that is sheltered from the elements. The instrument case is not to be considered water tight by the customer. In areas where the ambient temperature is expected to drop below 32°F, auxillary heating must be provided.

An outline diagram showing the location and identification of the gas line and electrical conduit connections, as well as the physical dimensions of the analyzer, is included among the drawings at the rear of the manual.

After the panel cutout has been made, TAI suggests that the mounting holes be line drilled using the analyzer case itself as a template. Wherever possible, the analyzer should be mounted at near eye level so that its output meter can be easily read.

2.2 Electrical Connections. All customer electrical wiring is to be connected to the terminal strip located behind the access cover at the rear of the analyzer. Refer to the interconnection diagram in the drawing section (back of the manual), and be sure that the wiring installation complies with the directions contained on the drawing and in the following sub-sections.

2.2.1 Power. A source of single phase, 198 to 242 volt, 50 or 60 cycle power, capable of delivering a 1/4 ampere of current continuously, is required to operate the Model 315 analyzer.

Power connections are to be polarized as indicated on the interconnection diagram ("HOT" or high side to the terminal identified "H"; neutral to the "N" terminal).

An equipment ground wire of the same gauge as the power service (nominally 16 ga) is to be connected to the terminal identified "G" on the interconnection diagram. This connection must be made in order to give the electronic circuitry a proper earth ground reference -- as well as to provide proper short circuit protection for operating personnel.

2.2.2 Signal. The Model 315 is equipped to provide an output signal. The magnitude of the available signal can be preset by TAI from 0-1 millivolt DC (full scale) to 0-1 volt DC (full scale) and should be specified by the customer at the time of purchase. Unless otherwise specified, the output will be 0-1 volt DC. Refer to the "Specification Data" Section of the Manual to determine the output signal magnitude.

The output signal, regardless of magnitude, is suitable for driving external devices that have an input impedance of 10,000 ohms or more.

Two conductor shielded cable is recommended for interconnection purposes (particularly for those instruments whose output signal magnitude is in the lower millivolt range). Polarize the signal connections as shown on the interconnection diagram, and connect the shield at the analyzer only.

2.3 Gas Connections. The sample input and vent connections are 1/8 Swagelok, and are located on the lower rear of the analyzer case. Both are identified on the outline diagram. TAI suggests that Teflon sealing tape be used as a sealant rather than pipe dope. BE SURE THAT MATING FITTINGS ARE NOT CROSS-THREADED BEFORE APPLYING FORCE WITH A WRENCH.

2.3.1 Sample Line Installation. The Model 315 is equipped with a throttle valve and flowmeter for sample path flow control. The integral flow path also features a shutoff valve that is located downstream from the Micro-fuel Cell manifold. When closed, these two valves isolate the cell from the high oxygen concentration of air. TAI takes advantage of this feature by shipping the instrument with the cell in place. Prior to shipment, the sample system is purged with either the customer's background gas (when practical) or an inert gas, such as Nitrogen. When the instrument indicates a stable, low ppm oxygen level, the two valves are closed, and the cell is maintained in a virtually oxygen free atmosphere until the instrument is installed and ready for use.

IF RELATIVELY SHORT STARTUP TIME AND CELL CONSERVATION ARE IMPORTANT, THESE TWO VALVES SHOULD NOT BE TAMPERED WITH UNTIL THE INSTALLATION PROCEDURE IS COMPLETED, AND SAMPLE FLOW CAN BE INITIATED.

The following sub-sections outline the required accessories and considerations that are important to proper sampling system construction.

2.3.1.1 Input Selector Manifold. It will be necessary for the customer to construct a simple two valve selector manifold to facilitate the introduction of either sample or calibration (span) gas into the analyzer. The valves should be selected on the basis of their ability to completely seal when closed. As an added precaution, TAI suggests that the span gas be shut off at its source when not in use. Such a procedure will obviate the possibility of span gas contamination of the sample.

2.3.1.2 Recommended Span Gas. The Model 315 has been specifically designed to employ air as its calibration gas. TAI feels that the known oxygen concentration of air (20.9%) is the most reliable standard available. The volume represented by the cell manifold and sample passages has been reduced to a minimum so that the instrument will recover rapidly to X1 range (0-10 ppm) analysis when the proper calibration procedure is followed.

2.3.1.3 Pressure Reduction and/or Regulation. TAI recommends that the sample pressure be reduced at the sample point to between 5 and 50 psig (10 psig nominal). If the magnitude of the sample pressure does not exceed 100 psig and is reasonably stable, a simple throttle valve will be satisfactory. If, on the other hand, the pressure is in excess of 100 psig or vacillates over a wide range, a metallic diaphragm regulator should be employed. DO NOT USE A REGULATOR THAT IS EQUIPPED WITH AN ORGANIC MATERIAL DIAPHRAGM UNDER ANY CIRCUMSTANCES.

If the span gas is a certified composition, its supply cylinder must also be equipped with a metallic diaphragm regulator. If the span gas is instrument air, a metallic diaphragm type regulator is not required -- as diffusion will not alter its oxygen concentration. When compressor supplied, a throttle valve should be adequate.

2.3.2 Vent Line Installation. Wherever possible, TAI recommends that the analyzer be allowed to vent directly to the atmosphere. If a vent line is required, the following conditions apply to its installation:

- 1) The vent line must be constructed of 1/8 inch tubing (or equivalent) and be as short as possible, so that no back pressure from restricted flow is experienced by the Micro-fuel Cell.
- 2) The vent line must terminate in an area that experiences no more than normal barometric pressure changes.
- 3) The vent line must be installed so that water and dirt cannot accumulate in it.

2.3.3 Zero (or near zero) Pressure Sampling. The Model 315 can be configured by TAI to operate in applications where the sample pressure is either zero or near zero. SUCH AN APPLICATION SHOULD BE SPECIFIED AT THE TIME OF PURCHASE.

To eliminate any possibility of diffusion contamination, TAI recommends that the necessary sample pump be placed downstream from the analyzer in vacuum service, so that the sample is drawn through the analyzer from the sample point. TAI rearranges the integral sampling path (at no extra cost) so that the throttle valve is located downstream from the cell. This procedure prevents the cell from experiencing a partial pressure environment.

TAI includes a piping schematic of the analyzer which also depicts a recommended sampling system (see drawing section at the rear of the manual).

3. STARTUP

3.1 Preliminary. Before supplying power to the instrument, TAI suggests that the electrical wiring installation be checked against the interconnection diagram -- particularly, if the installation has been made by a panel fabricator or personnel other than those responsible for startup and operation.

All accessory hardware and fittings upstream from the analyzer should be leak tested under pressure prior to startup.

In many instances, proper attention to these two preliminary steps will prevent severe damage (accidental wiring transposition) and ambiguous analysis of the sample (diffusion leaks in the sampling system).

3.2 Meter Zero. Before turning the power to the analyzer on, the mechanical zero of the meter should be checked and adjusted, if necessary. The meter indicating pointer should be in coincidence with the zero mark of the scale. Use the mirror to eliminate parallex, and adjust the screw on the face of the meter until the pointer indicates exactly zero. IMPORTANT: Never attempt to make this adjustment with the power on.

3.3 Electrical Startup. Select the "CAL" range and move the power switch to ON. Wait a minimum of ten (10) seconds to allow the power supplies to reach full voltage capacity.

The meter moves upscale and comes to equilibrium at a point that represents the actual concentration of oxygen in the sampling system between the throttle valve and shutoff valve. The actual reading is a function of the setting of the "span" potentiometer and the diffusion penetration of air into the cell manifold. It is impossible to achieve a "perfect" seal of the sampling system. What the meter is indicating is the diffusion -- consumption balance point of the integral sampling system and the Micro-fuel Cell.

If the meter reads more than one small division, the probability is that one or both of the valves have been tampered with. If this is the case, no damage has occurred, but a longer length of time will be required to purge the instrument before it is ready for use.

3.4 Sample Startup. After power has been established, arrange the input selector valves so that the sample gas is being presented to the analyzer, and start sample flow as follows:

- 1) Open the "cell shutoff" valve first.
- 2) Open the throttle valve and adjust it until the flowmeter indicates a flowrate of 1.0 scfh. Final adjustments on the sample pressure reducing system should be made at this time -- so that the analyzer input pressure is nominally 10 psig.

The analyzer should start to respond to the oxygen concentration in the sample gas immediately. Follow the advance or decline of the reading with the range selector switch until you reach the range that will give you the highest possible resolution of the sample.

If air was not permitted to diffuse into the analyzer prior to the start of sample flow, the analyzer will be ready for calibration in a matter of moments. If, however, the analyzer performs as described in the final paragraph of Section 3.3, the analyzer should be permitted to run on the sample gas until a stable low reading is achieved.

3.5 Calibration. Employ the following procedure when calibrating the analyzer:

- 1) Arrange the input manifold so that span gas is flowing through the analyzer.
- 2) Readjust the throttle valve (if necessary) so that the flowrate is 4.0 scfh.
- 3) Place the range switch on the "CAL" position if the span gas is air, or on the position that will give the best possible resolution of the oxygen content of the span gas.
- 4) Unlock and adjust the "span" control knob until the meter pointer is in coincidence with the "CAL" mark on the scale (air calibration), or in agreement with the oxygen content of the span gas. Be sure that the reading is stable, and then relock the control knob.
- 5) Rearrange the input manifold so that sample gas is again flowing through the analyzer.

Calibration (particularly when the span gas is air) should be accomplished as rapidly as possible, and the analyzer returned to the sample gas as soon as it is calibrated. The longer the instrument is exposed to the 209,000 ppm oxygen concentration of air, the longer it will require to return through the more than 4 decades of range differential to 10 ppm full scale sensitivity. The instrument should recover completely to 1 ppm resolution after an overnight purge with sample gas.

4. ROUTINE OPERATION

4.1 Sample Flow. To avoid creating a significant positive pressure on the Micro-fuel Cell, which would detract from the accuracy of the analysis, flowrate should always be kept within the range of the integral flowmeter. The flowmeter, which is located downstream from the cell, presents a tolerable impedance to sample flow when the flowrate is within its range of measurement. Increasing the flow beyond the limits of the flowmeter increases the impedance it represents, and a resulting back pressure is developed. Since the cell is a partial pressure sensitive device, the accuracy of the measurement will suffer accordingly. To meet advertised specifications, the flowrate need be no greater than 1.0 scfh.

4.2 Calibration. No prescribed routine calibration period is recommended. TAI feels that the intervals between calibration should be dictated by the customer's application. If the instrument is being used to certify the oxygen content of a product for delivery, then, a calibration of the instrument prior to certification would certainly be in order. If, on the other hand, the instrument is being used to monitor or guard a process for predetermined limits of acceptability, the customer's knowledge of his process and the evidence provided by the instrument will in themselves determine when a calibration check is in order.

4.3 Shutdown and Startup of Sample Path Flow. Whenever it becomes necessary to cut off the sample flow to the instrument, the following prescribed procedure should be used to minimize the diffusion of air into the instrument, and thereby maintain the cell in a low ppm oxygen environment.

1) Reduce the flowrate so that the flowmeter float is just barely indicating.

2) Close the cell shutoff valve, and in the case of humidifier equipped instruments, the tank assembly valve completely.

3) Close the throttle valve completely.

If the valves are completely closed, the output indication will eventually come to equilibrium off scale in the 0-100 ppm range and less than one minor division on the "CAL" range.

When gas flow is to be restarted, open the cell shutoff valve first, and then immediately open and adjust the throttle valve.

5. MAINTENANCE

5.1 Routine Maintenance. The Micro-fuel Cell is a sealed, modular component that need only be replaced when at fault, (normally at six month intervals or longer).

5.2 Cell Replacement. The characteristics of the Micro-fuel Cell are similar to those of a mercury battery in that both provide an almost constant output through their useful life, and then fall off sharply towards zero at the end. If the process being analyzed has a low oxygen concentration, cell failure will probably be indicated by the inability to properly calibrate the analyzer when using span gas. The user will find that very little adjustment of the 10 turn span potentiometer will be required to keep the analyzer calibrated properly during the duration of a given cell's useful life. If large, many turn adjustments (cw) are required to calibrate the instrument, or calibration cannot be achieved within the range of the control, the cell should be immediately replaced.

To offset the possibility of not having a replacement cell available when it is needed, TAI recommends that a spare cell be purchased shortly after the instrument is placed in service, and each time the cell is replaced thereafter.

The spare cell should be carefully stored in an area that is not subject to large variations in ambient temperature (75°F nominal), and in such a way as to obviate any possi-

bility of incurring damage. Under no circumstances, disturb the integrity of the cell package until the cell is to be actually used. If the cell package is punctured and air permitted to enter, the cell will immediately start to react to the presence of oxygen.

No tools are required to replace the cell in the instrument (beyond a screwdriver to remove the cover plate). The cell is beneath the black cover marked "Cell" located on the front of the analyzer. To remove a depleted cell, remove the three screws in the cover plate. Remove the cover plate and expended cell.

Remove the new cell from its package, and carefully remove the shorting clip. Do not touch the silver colored sensing surface of the cell -- as it is covered with a delicate Teflon membrane that can be ruptured in handling.

Place the new cell contact plate first into the cell manifold and replace the cover and screws.

After the cell has been installed, proceed as directed in Sections 3.4 and 3.5 of the Manual.

5.3 Cell Warranty. The Class B-2 cell employed in the Model 315 is warranted for 40,000 percent-hours or six (6) months of service (whichever occurs first).

With regard to spare cells, service time starts when the cell is removed from its shipping package. The customer should stock only one spare cell per instrument at a time. Do not attempt to stockpile spare cells.

The Model 315 should not be used in applications where CO₂ is a major component in the sample. Concentrations of 1,000 ppm or less will not effect the cell performance.

If a cell was working satisfactorily, but ceases to function before the warranty period expires, the customer will receive credit, on a pro-rated basis, toward the purchase of a new cell.

Customers having warranty claims must return the cell in question to the factory for evaluation. If it is determined that failure is due to faulty workmanship or material, the cell will

be replaced at no cost to the customer. WARNING: Evidence of damage due to tampering or mishandling will render the cell warranty null and void.

6. TECHNICAL INFORMATION

6.1 Transduction and Temperature Compensation. The TAI Model 315 Trace Oxygen Analyzer utilizes a unique electrochemical transducer whose features include:

- 1) Specificity for oxygen.
- 2) Maintenance free operation.
- 3) Long calibration interval and life.
- 4) Disposable configuration.
- 5) Low cost.

The transducer functions as a fuel cell; in this instance, the fuel is oxygen. Oxygen diffusing into the cell reacts chemically to produce an electrical current that is proportional to the oxygen concentration in the gas phase immediately adjacent to the cells sensing surface.

The cell has an inherent positive temperature coefficient, the effects of which have been minimized through the implementation of a calibrated thermistor compensation circuit. The instrument is cycled through the operating temperature range (32 to 125°F) and the value of resistor R21 (see schematic) will produce the advertised accuracy specification ($\pm 2\%$ of scale or $\pm 5\%$ of reading, whichever is greater). The reader should understand that the $\pm 5\%$ of reading specification is a derivative of the wide operating temperature range, and that at a constant temperature, the accuracy is $\pm 2\%$ of scale.

This calibration is accomplished by TAI, and under no circumstances should the setting of any circuit board trimmer be tampered with unless under the direct supervision of an authorized TAI representative.

6.2 Output Circuit. The Model 315 output circuit (meter and external signal) has been designed so that when the instrument is properly calibrated, precisely one (1) volt potential difference exists between the slider and ccw terminal of the span potentiometer (P1) when full scale (any range) oxygen is being sensed by the cell. TAI standardizes the output to within ± 0.5 mv DC with a differential volt meter, and then adjusts the meter (trimmer R18) so that it reads exactly full scale. The output signal can be preset to meet the customer's requirement through the proper selection of a voltage divider (R15 and R16).

7. SPECIFICATION DATA

7.1 TAI SALES ORDER NUMBER:

7.2 INSTRUMENT MODEL NUMBER: 315

7.3 INSTRUMENT SERIAL NUMBER:

7.4 MICRO-FUEL CELL CLASS:

7.5 ACCURACY $\pm 2\%$ OF SCALE AT CONSTANT TEMPERATURE:
 $\pm 2\%$ OF SCALE OR $\pm 5\%$ OF READING, WHICHEVER IS GREATER, OVER
THE OPERATING TEMPERATURE RANGE.

7.6 OPERATING TEMPERATURE RANGE: 32 to 125⁰F

7.7 RESPONSE AND RECOVERY: AT THE SPECIFIED FLOWRATE
(0.25 SCFH), 90% IN 10 SECONDS ON THE X10 RANGE AND 90% IN
60 SECONDS ON THE X1 RANGE.

7.8 OUTPUT SIGNAL:

7.9 RANGES OF ANALYSIS:

7.10 RECOMMENDED SPAN GAS: COMPRESSED AIR

TAI SERIES 315

RECOMMENDED SPARE PARTS LIST

<u>QUANTITY</u>	<u>PART NO.</u>	<u>DESCRIPTION</u>
5 ea	F-39	Micro-fuse, 1/4 Amp
1	A-6689	Micro-fuel Cell, Class B-2

Orders for spare parts must include the model and serial numbers of the instrument for which the parts are intended.

A Minimum Charge of \$ 20.00 applies to Spare Parts Orders.

Orders should be sent to:

Teledyne Analytical Instruments

16830 Chestnut Street

City of Industry, CA 91748-1580

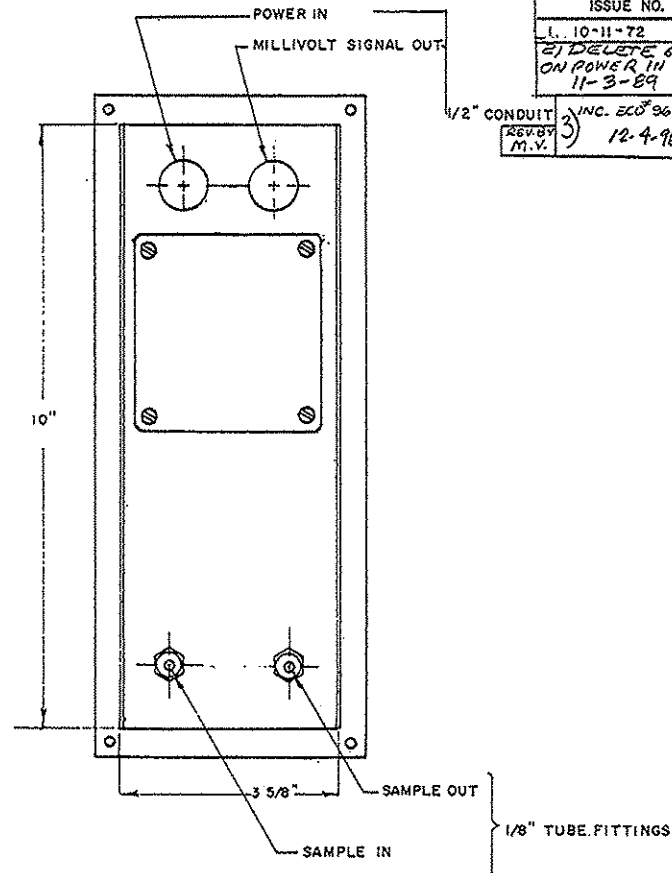
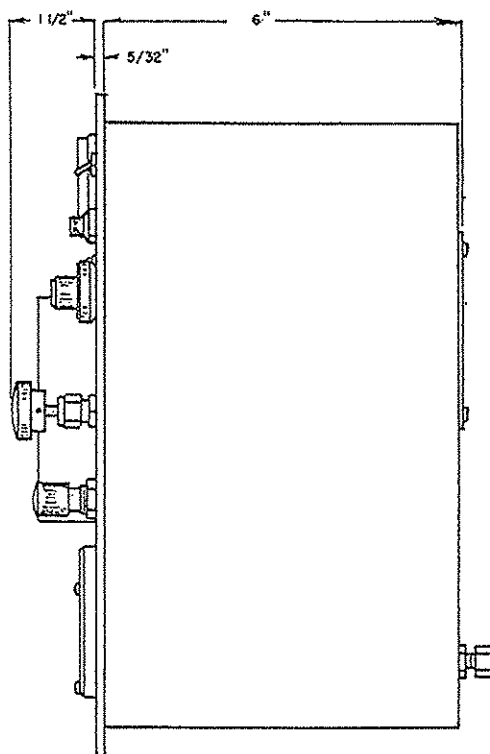
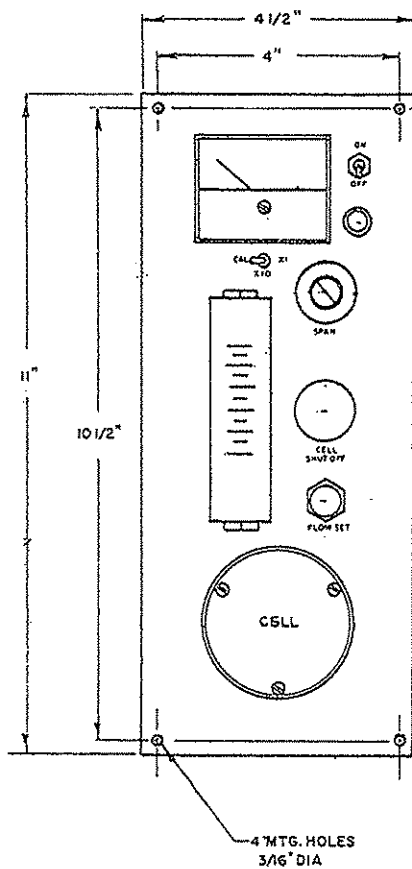
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DRAWING LIST
MODEL 315X

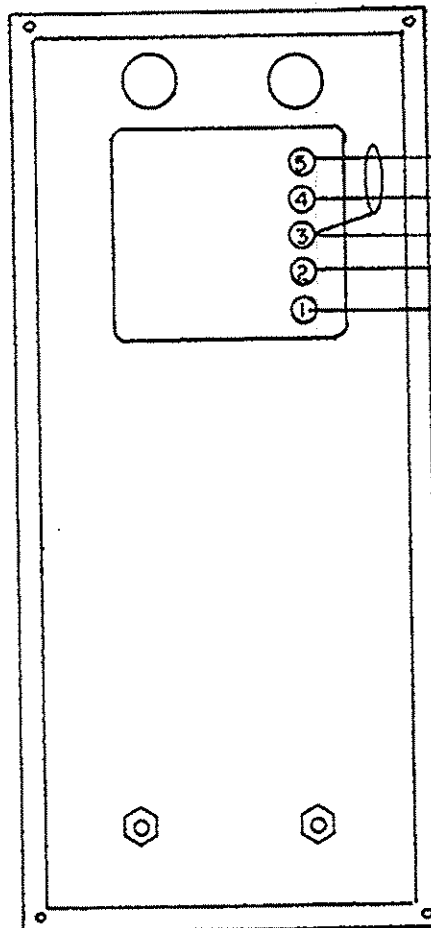
B-11020	Analyzer Outline Diagram
A-11019	Interconnection Diagram
A-11026	Piping Schematic
C-14270	Schematic
A-14141	O ₂ Cell Delay Board Installation Diagram



ISSUE NO.	APP.
1. 10-11-72	
2. DELETE 60 Hz ON POWER IN 11-3-89	
3. INC. ECO 96-1095	
REV. BY M.V.	12-4-96

NOTE: RECOMMENDED PANEL CUTOUT DIMENSIONS: 10 1/8" X 3 13/16"

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TOLERANCE UNLESS OTHERWISE SPECIFIED	FRACT. $\pm 1/64$	DEC. $\pm .003$	ANGULAR $\pm 1/2^\circ$
ANALYTICAL INSTRUMENTS A TELEDYNE COMPANY SAN GABRIEL, CALIFORNIA		SCALE	DATE 10-11-72
		MATERIAL	
TRACE OXYGEN ANALYZER MOL. 315, 325 OUTLINE DIAGRAM		FINISH	
		DR G	ENGR
		B-11020	



ISSUE NO.	APP.
1. 10-11-72	g

NOTES: GROUND SHIELD OF SIGNAL CABLE
AT ANALYZER ONLY AS SHOWN.
DO NOT GROUND EITHER OUTPUT
SIGNAL LEADS.
POWER & SIGNAL LEADS SHOULD
BE PLACED IN SEPARATE CONDUITS.

WIRE RECOMMENDATIONS:
SIGNAL: 22 GA. SHIELDED CABLE
POWER & GROUND: 16 GA.

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TOLERANCE UNLESS OTHERWISE SPECIFIED

FRACT. $\pm 1/64$

DEC. $\pm .003$

ANGULAR $\pm 1/2^\circ$



ANALYTICAL INSTRUMENTS

A TELEDYNE COMPANY
SAN GABRIEL, CALIFORNIA

TRACE OXYGEN ANALYZER
MDL. 315, 325
INTERCONNECTION DIAGRAM

SCALE —

DATE 10-11-72

MATL

FINISH

DR G

ENGR

APP

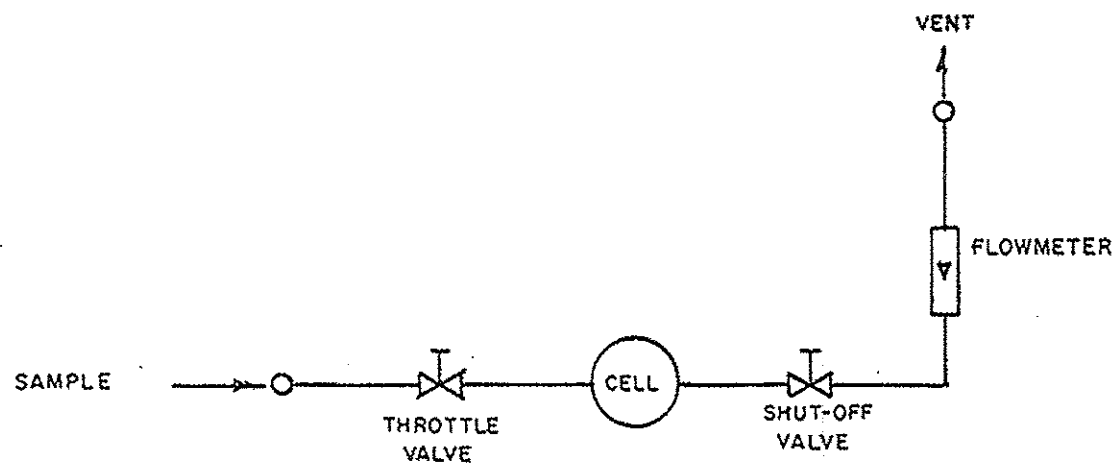
A-11019

ISSUE NO.

1. 10-23-72

APP.

G



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TOLERANCE UNLESS OTHERWISE SPECIFIED

FRACT. $\pm 1/64$ DEC. $\pm .005$ ANGULAR $\pm 1/2^\circ$ 

ANALYTICAL INSTRUMENTS

A TELEDYNE COMPANY
SAN GABRIEL, CALIFORNIA

TRACE OXYGEN ANALYZER
MDL. 315, 325
PIPING SCHEMATIC

SCALE —

DATE 10-23-72

MATERIAL

FINISH

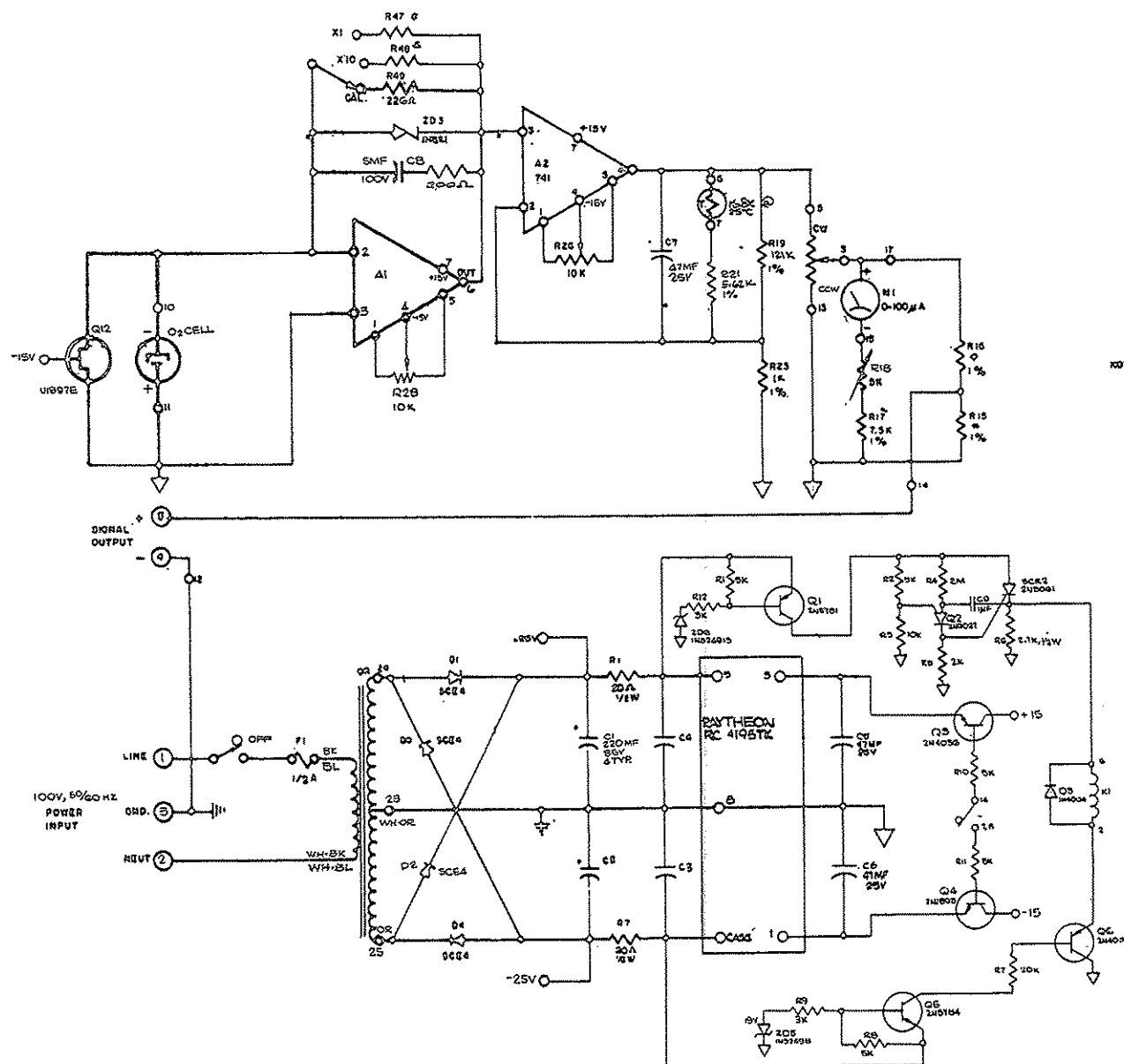
DR G

ENGR

APP

A-11026

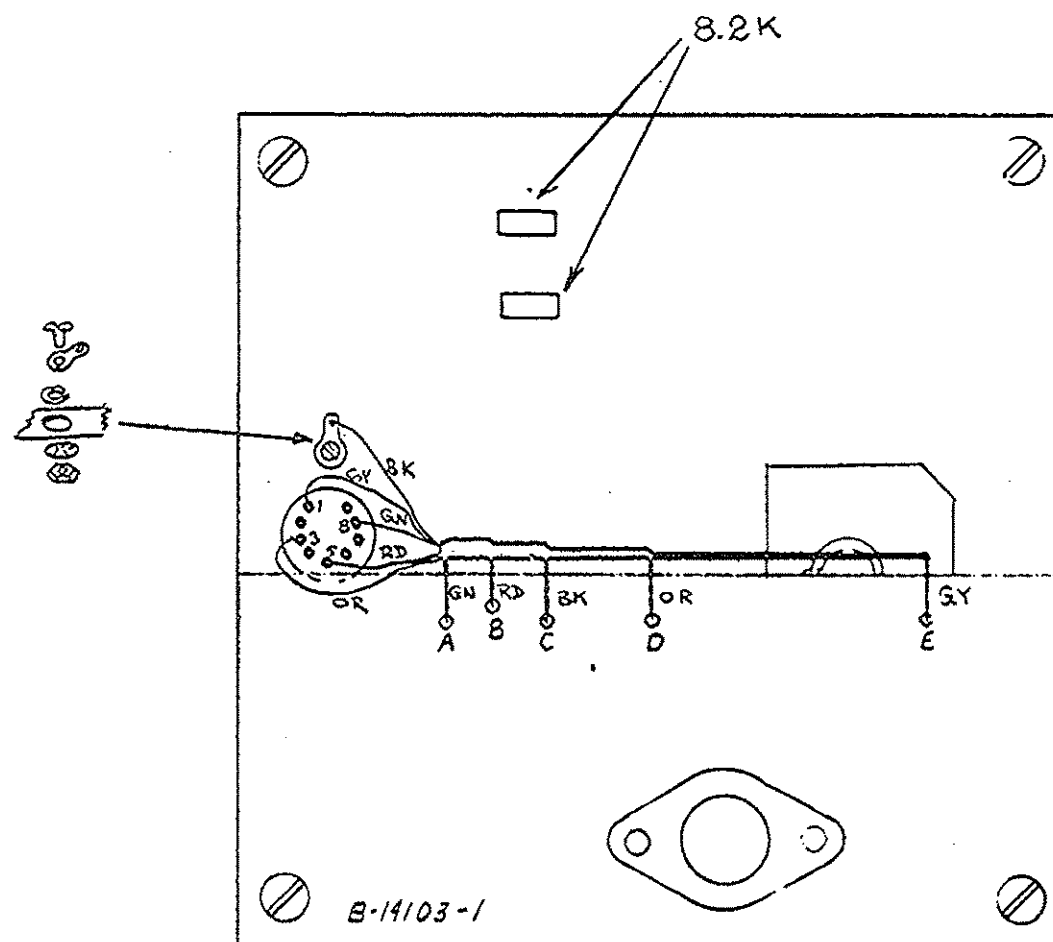
ISSUE NO.	APP.
1. 2-2-76	ES
REV. PER. 600 740 022	7
2. 10-10-78	
LCOB 1.0000	
3. 7-14-81	11L



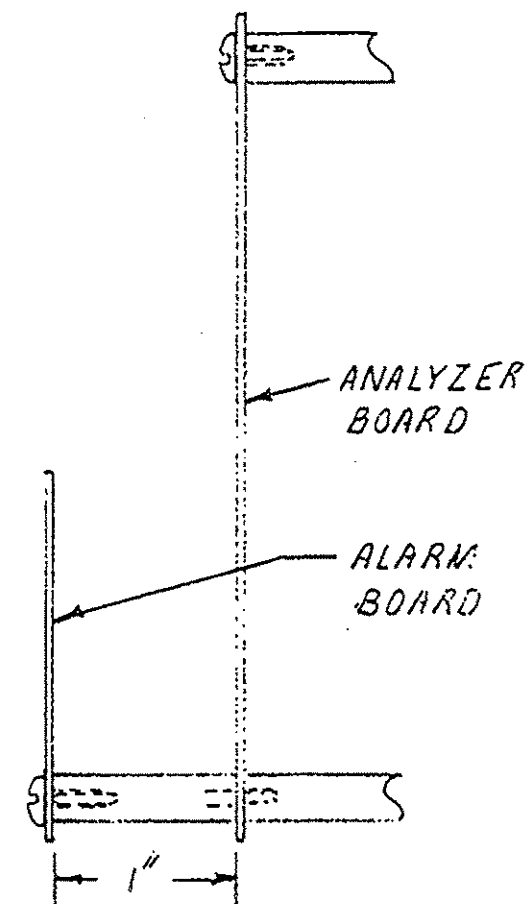
NOTE: RESISTORS MARKED \diamond ARE SELECTED FOR APPLICATION.

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TOLERANCE UNLESS OTHERWISE SPECIFIED	FRACTION 2 1/2	DEC. 2 200	ANGULAR 2 1/2
ANALYTICAL INSTRUMENTS		DATE 2-2-76	MAIL
A TELEPHONE COMPANY SAN GABRIEL, CALIFORNIA		FINISH	
TRACE OXYGEN ANALYZER MODEL 315X SCHEMATIC		OF H.U. ENGR	APP
		C-14270	

ISSUE NO.	APP.
1. 1-30-76	ES
REV. & REDRAWN 2. 4-7-76	9



COLOR CODE:
 BK = BLACK
 GY = GRAY
 GN = GREEN
 OR = ORANGE
 RD = RED



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TOLERANCE UNLESS OTHERWISE SPECIFIED

FRACT. $\pm 1/64$

DEC. $\pm .005$

ANGULAR $\pm 1/2^\circ$



TELEDYNE
ANALYTICAL INSTRUMENTS
 SAN GABRIEL, CALIFORNIA

O₂ CELL DELAY BOARD
 INSTALLATION DIAGRAM
 FOR MDL. 315

SCALE FULL

DATE 1-30-76

MATL:

FINISH:

DR ES

ENGR

APP

A-14141